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Memo

DATE: *May 25, 2007*

TO: RHIC E-Coolers

FROM: *Ady Hershcovitch*

SUBJECT: **Minutes of the May 25, 2007 Meeting**

Present: Natalia Abreu, Michael Blaskiewicz, Mike Brennan, Alexei Fedotov, Wolfram Fischer, Harald Hahn, Ady Hershcovitch, Derek Lowenstein, William Mackay, Eduard Pozdeyev, Thomas Roser, Anatoly Sidorin (JINR Dubna Russia), Dejan Trbojevic, Gang Wang, Alexander Zaltsman.

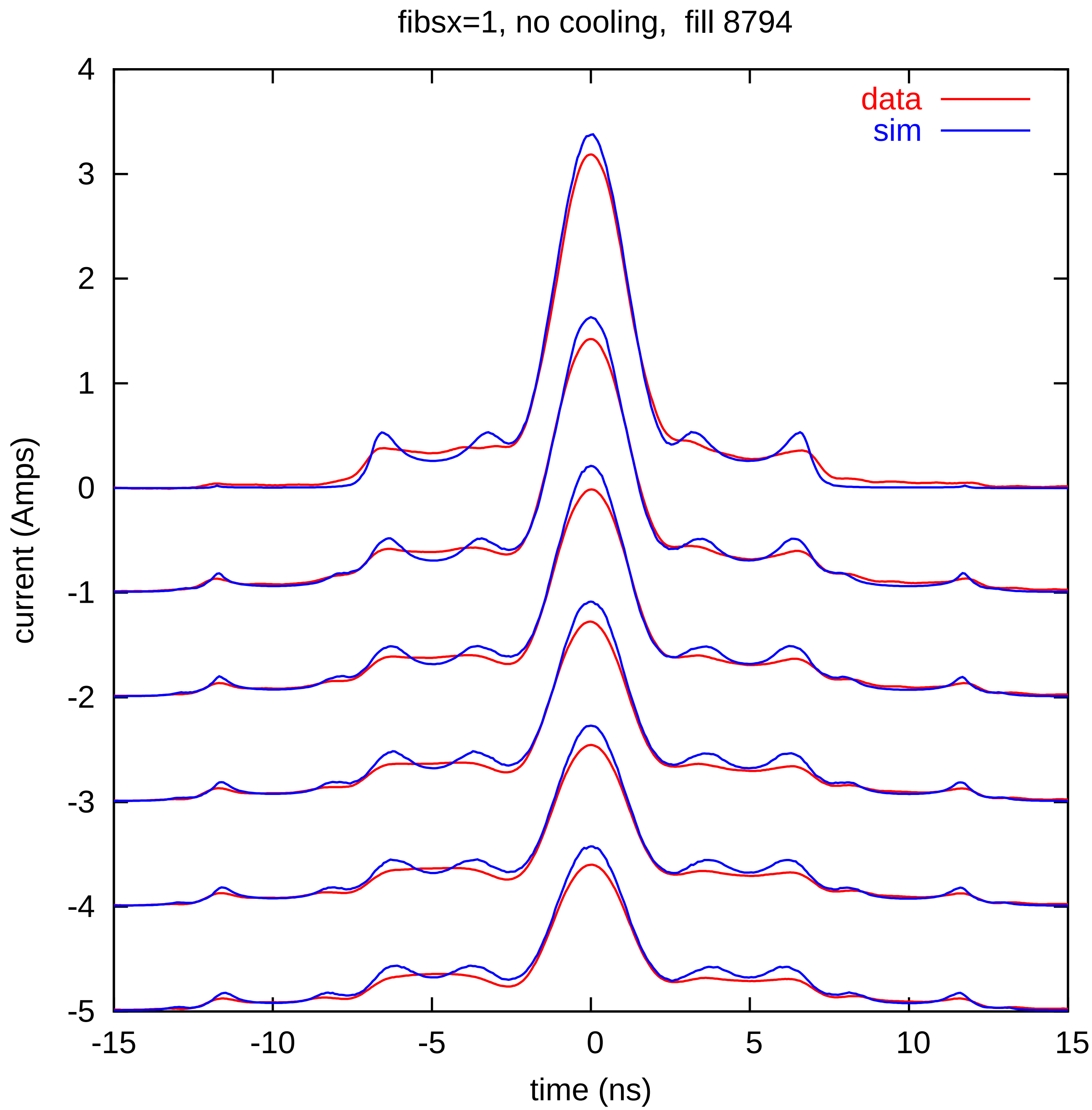
Topic discussed: Stochastic Cooling

Stochastic Cooling: during the meeting Mike Blaskiewicz presented theory, simulations and experimental results of stochastic cooling in RHIC. Mike started with a short review of the theory behind stochastic cooling. Basically, transverse stochastic cooling is a transverse wide-band damper comprising of pickups and kickers. First Mike described cooling theory without intrabeam scattering (IBS). Next came a description of Piwinski's theory of intrabeam scattering. The theory assumes the bunch is Gaussian in all three dimensions, which is a poor approximation to rebucketed beam in RHIC. Mike modified the theory by assuming that the local intrabeam scattering rate is proportional to the local line density of the particles. The rms values of momentum spread and betatron action are taken as constant along the bunch and the IBS kicks are normalized so that the rms parameters of a Gaussian bunch will evolve as they do in Piwinski's original equations. Additionally, since the cooling rate is inversely proportional to the number of particles, a simulation with 10^5 particles can be scaled to represent the behavior of a bunch with 10^9 ions. Mike introduced the same scaling into the IBS rates and stated that an internal consistency check had verified that everything scaled as expected. The simulations track only the x transverse dimension and assume that the emittance in the y transverse dimension is the same. There is one free parameter, the ratio of the x emittance growth rate to the value calculated using Piwinski's formulae. This ratio, fibsx, was set to either 0.5, or 1.

Graphs below show the results for several simulations. Plots 1 and 2 compare data and simulations for the effect of intrabeam scattering alone. Plot 3 compares the evolution of the transverse emittance in the two cases. Plot 4 shows the transverse emittance when the longitudinal cooling is on and strong. Plots 5 and 6 compare data and simulations for longitudinal cooling on. Plots 7 and 8 compare data and simulation with the cooling rate at 2/3 optimal. Plots 9 and 10 show the effect of fairly strong transverse cooling on the longitudinal profile. It is likely that fibsx=0.5 is more realistic than fibsx=1. Comparing the bottom trace on plot 6 and the top trace on plot 10 one can see that reducing the transverse emittance increases the longitudinal IBS rate. Plots 11 and 12 show the longitudinal mountain ranges for a smaller transverse cooling gain. There is less leakage into the satellites. Plots 13 and 14 show the evolution of the transverse emittance with cooling.

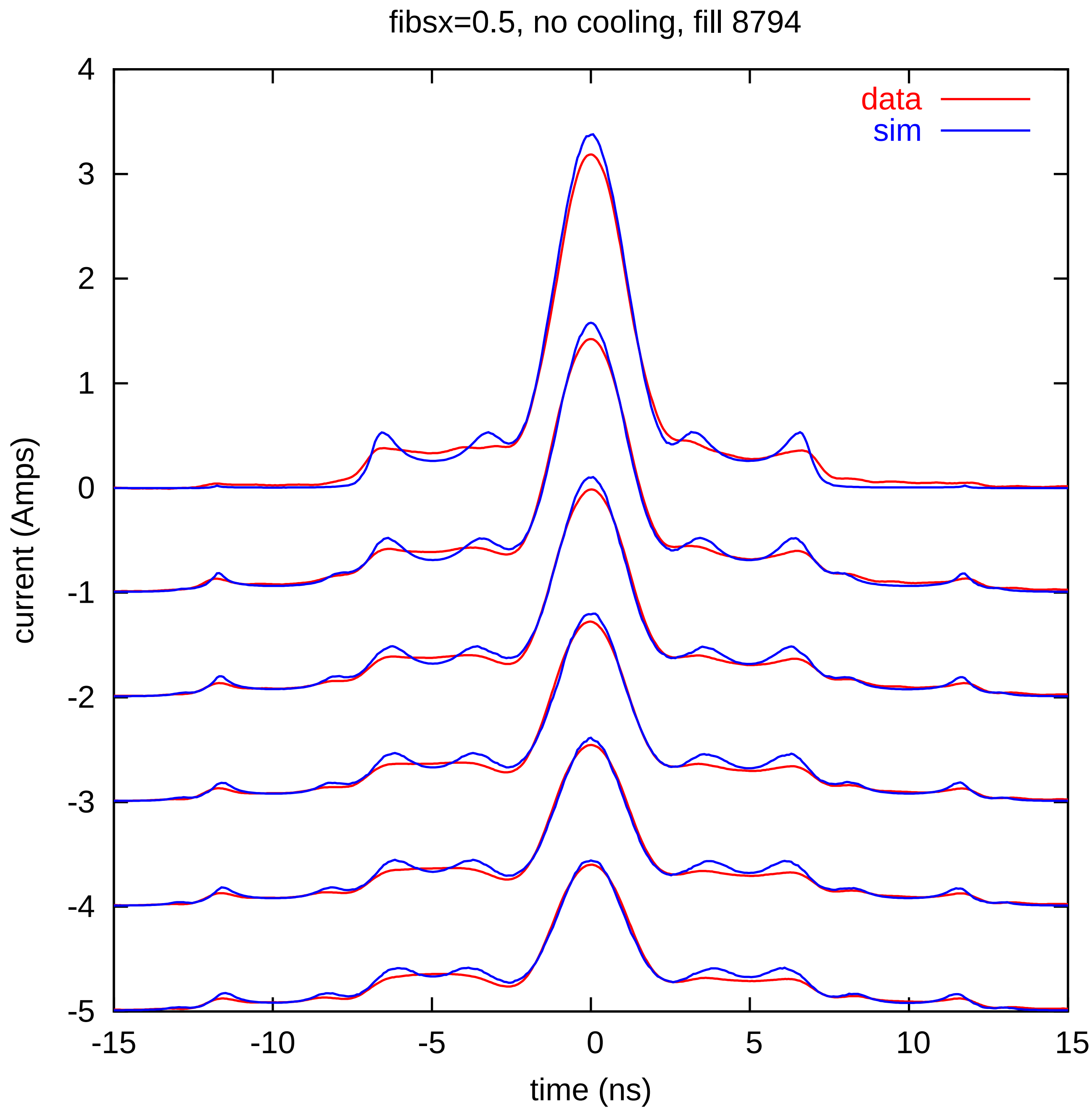
The meeting ended with a discussion regarding schemes to move ions from satellites back into the buckets.

Plot 1

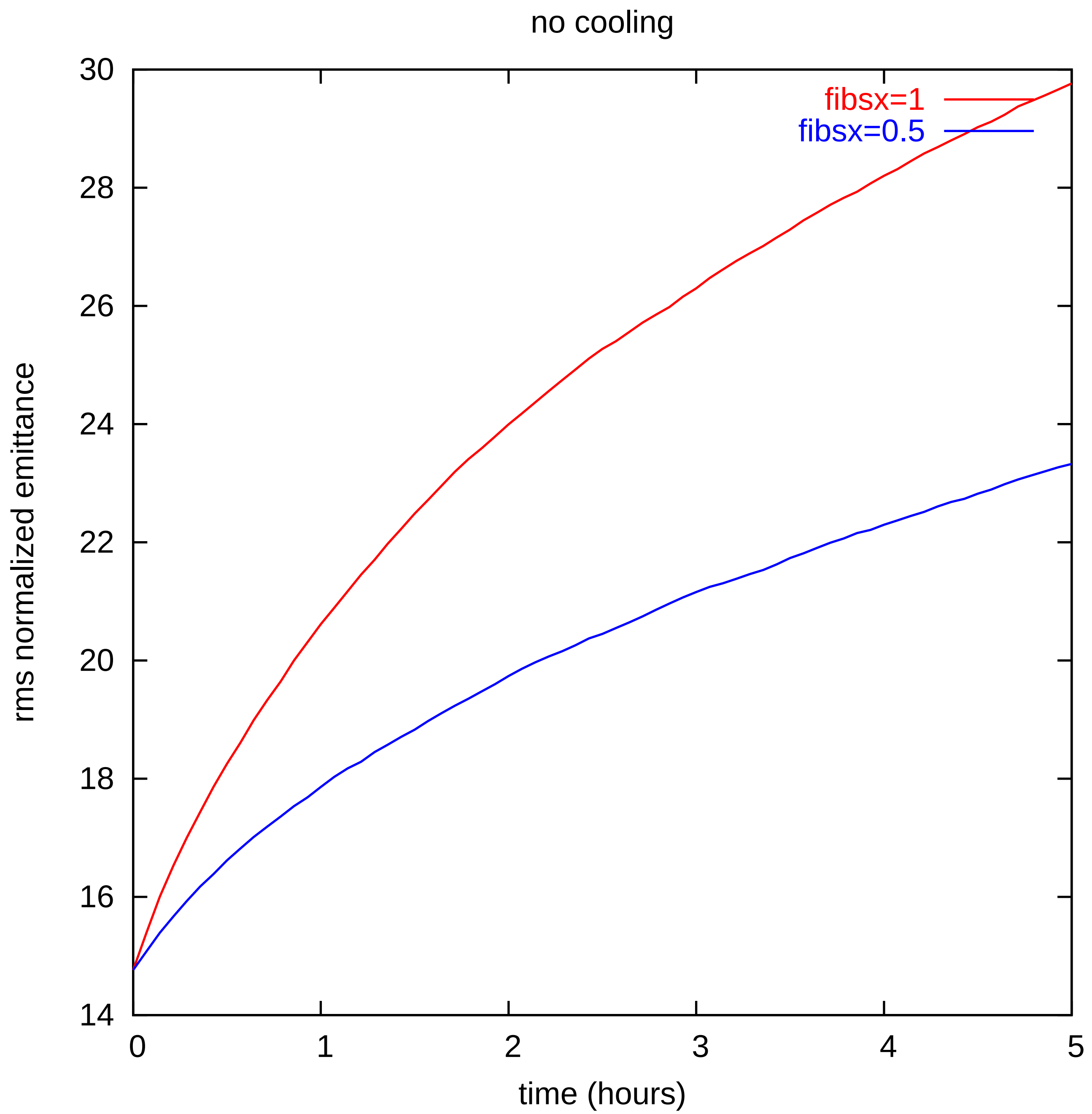


fibsx=1, no cooling, fill 8794
data
sim
current (Amps)
time (ns)
4
3
2
1
0
-1
-2
-3
-4
-5
-15
-10
-5
0
5
10
15

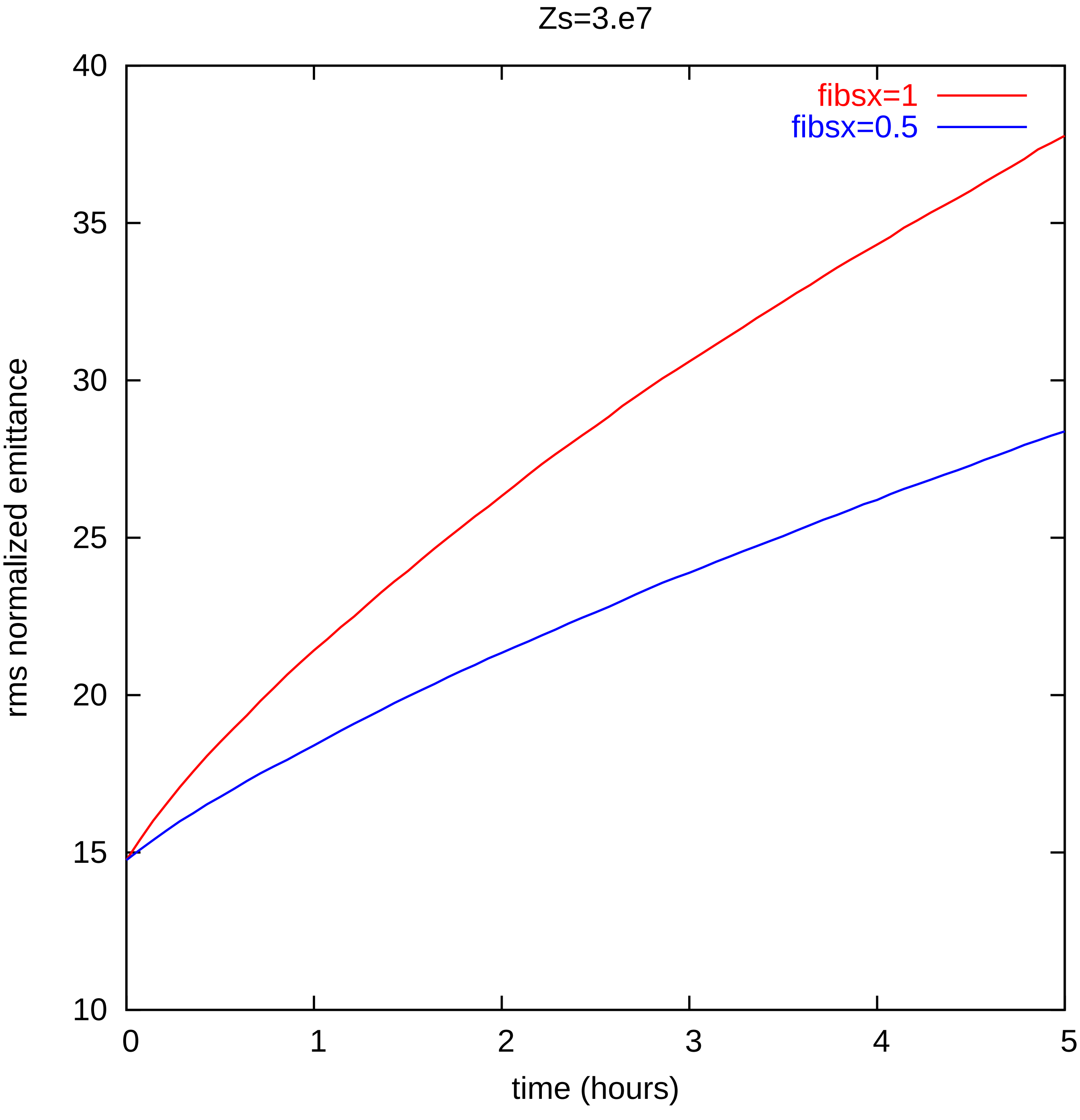
Plot 2


fibsx=0.5, no cooling, fill 8794
data
sim
current (Amps)
time (ns)
4
3
2
1
0
-1
-2
-3
-4
-5
-15
-10
-5
0
5
10
15

Plot 3

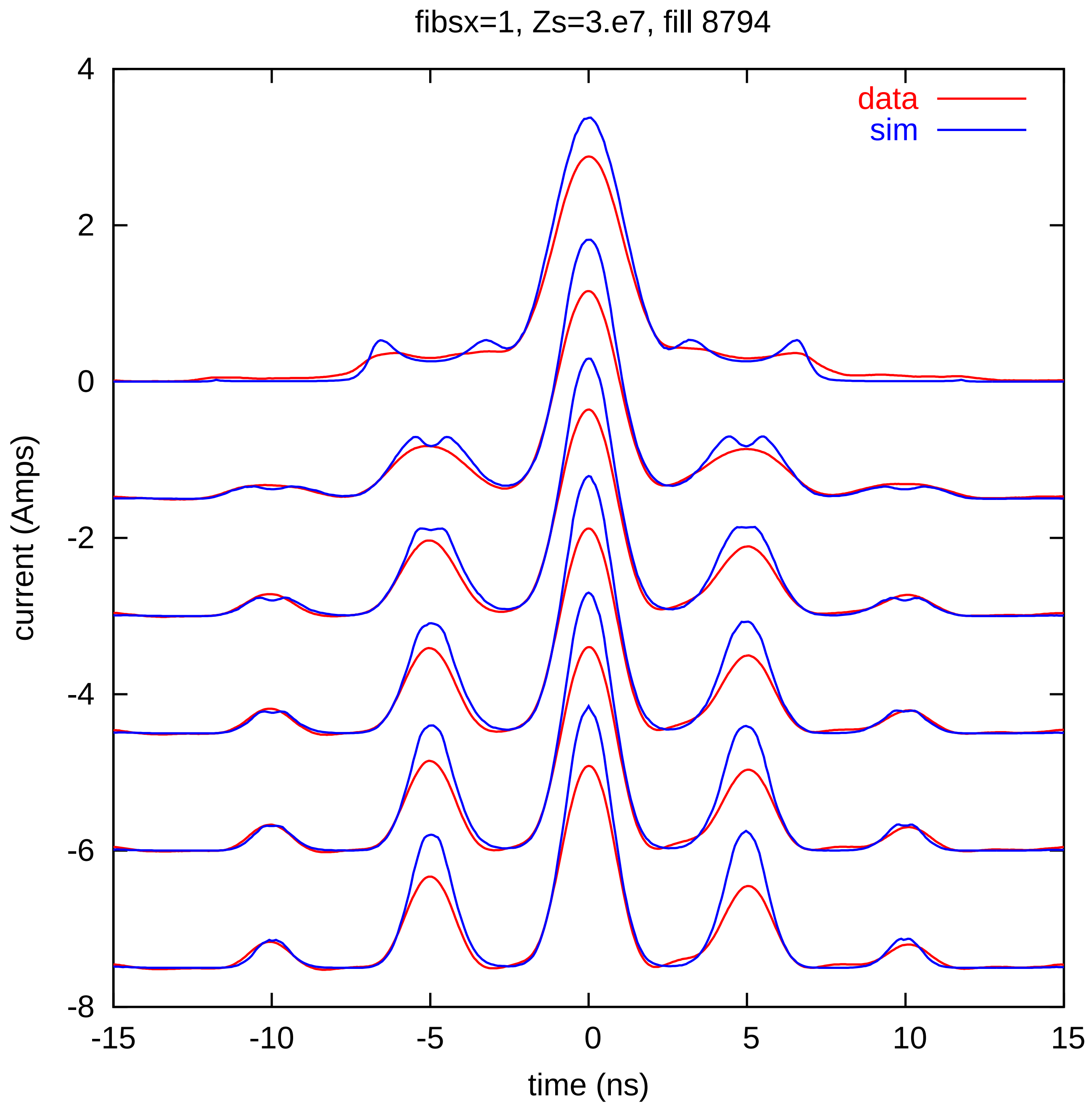

no cooling
fibsx=1
fibsx=0.5
rms normalized emittance
time (hours)
30
28
26
24
22
20
18
16
14
0
1
2
3
4
5

Plot 4



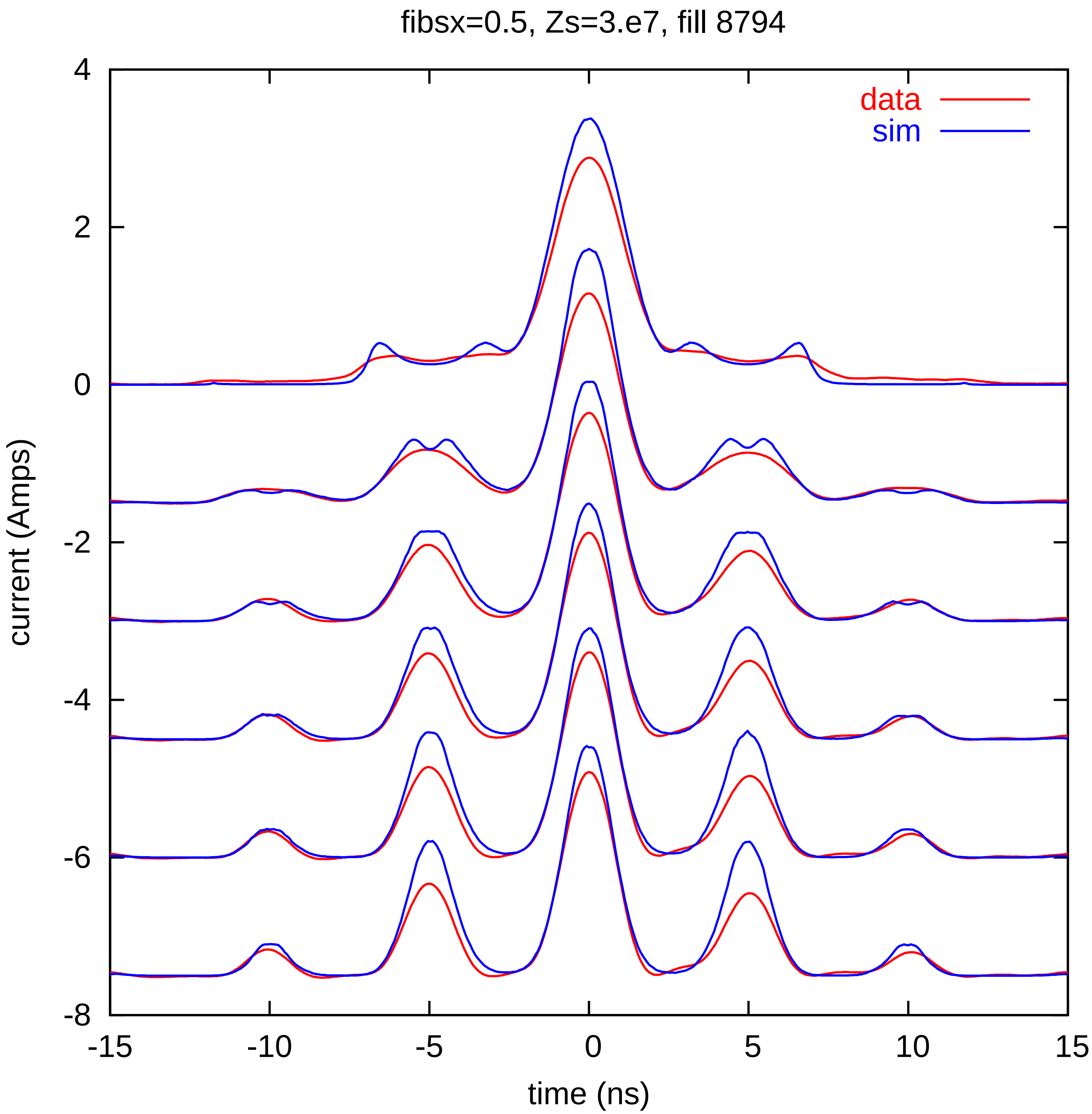
Zs=3.e7
fibsx=1
fibsx=0.5
rms normalized emittance
time (hours)
40
35
30
25
20
15
10
0
1
2
3
4
5

Plot 5



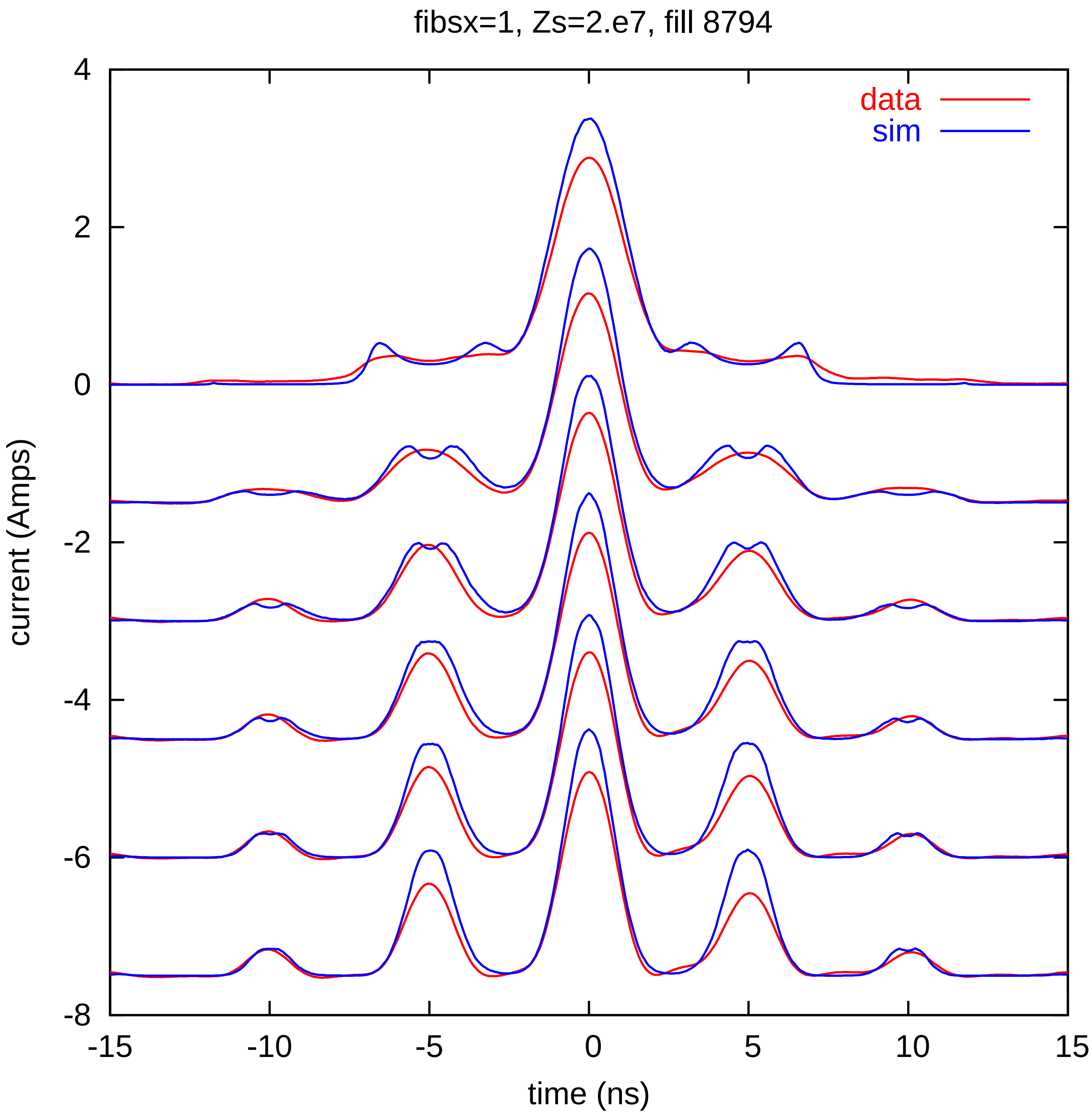
fibsx=1, Zs=3.e7, fill 8794
data
sim
current (Amps)
time (ns)
4
2
0
-2
-4
-6
-8
-15
-10
-5
0
5
10
15

Plot 6



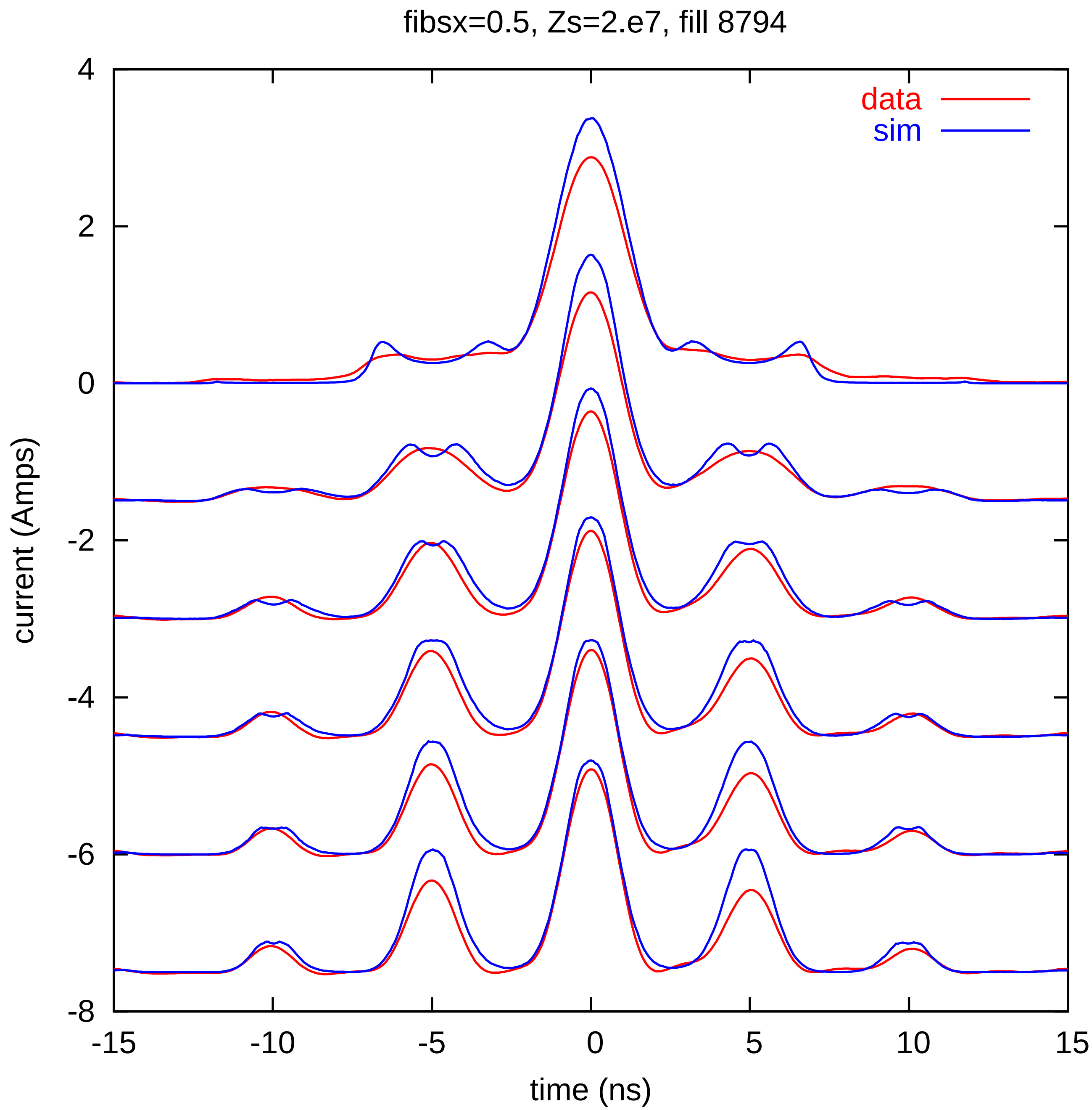
fibsx=0.5, Zs=3.e7, fill 8794
data
sim
current (Amps)
time (ns)
4
2
0
-2
-4
-6
-8
-15
-10
-5
0
5
10
15

Plot 7

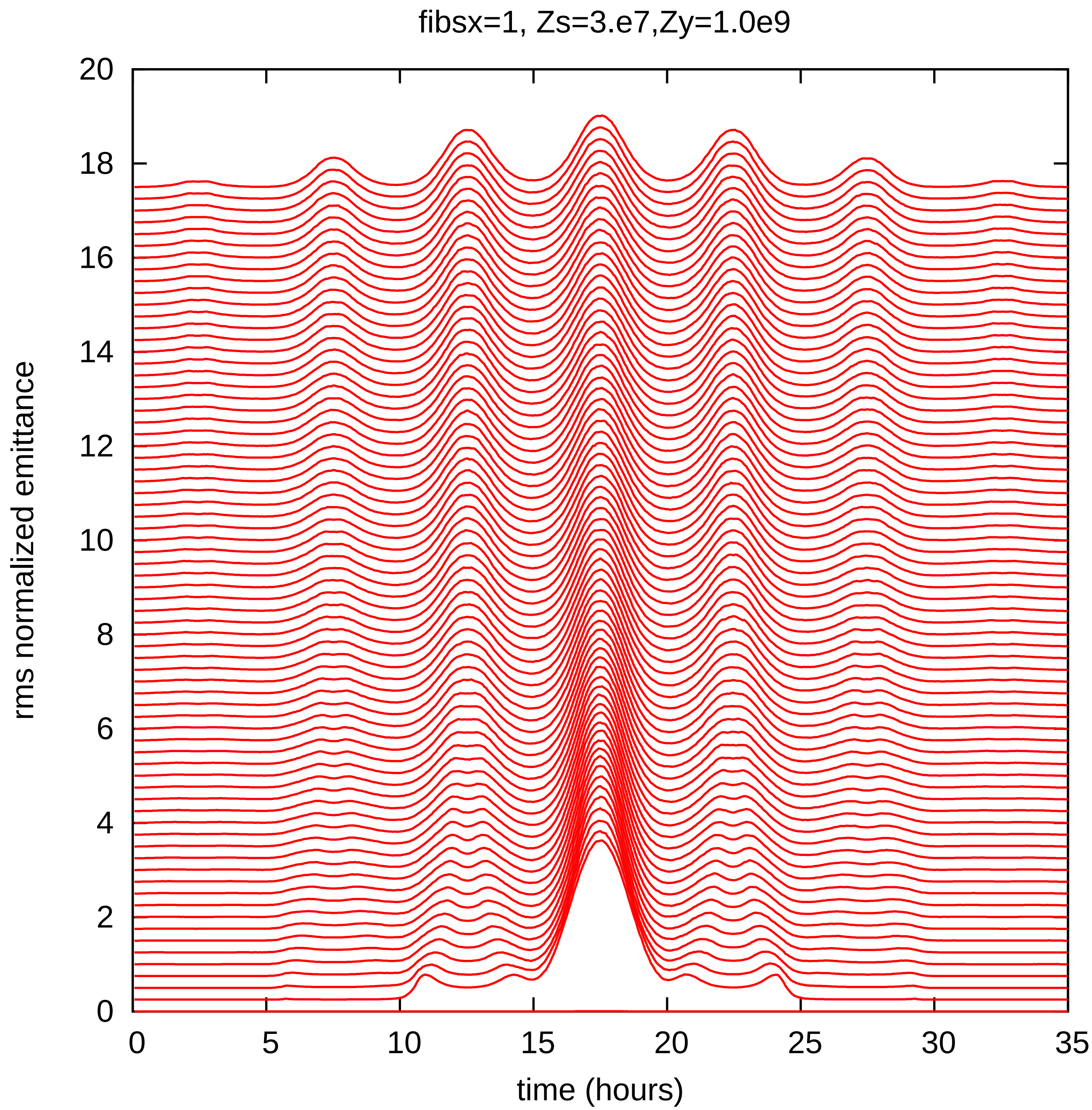


fibsx=1, Zs=2.e7, fill 8794
data
sim
current (Amps)
time (ns)
4
2
0
-2
-4
-6
-8
-15
-10
-5
0
5
10
15

Plot 8

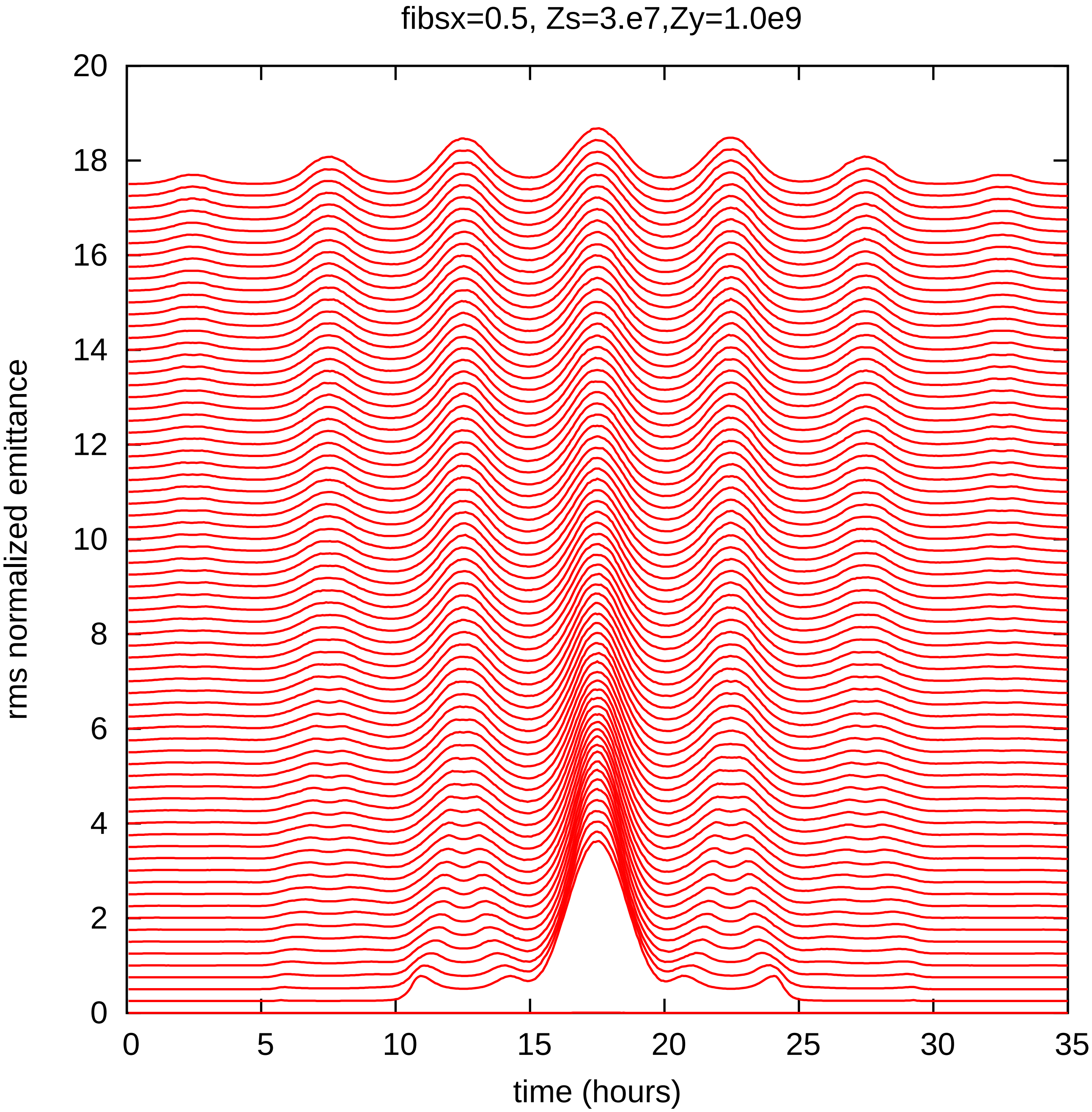

fibsx=0.5, Zs=2.e7, fill 8794
data
sim
current (Amps)
time (ns)
4
2
0
-2
-4
-6
-8
-15
-10
-5
0
5
10
15

Plot 9



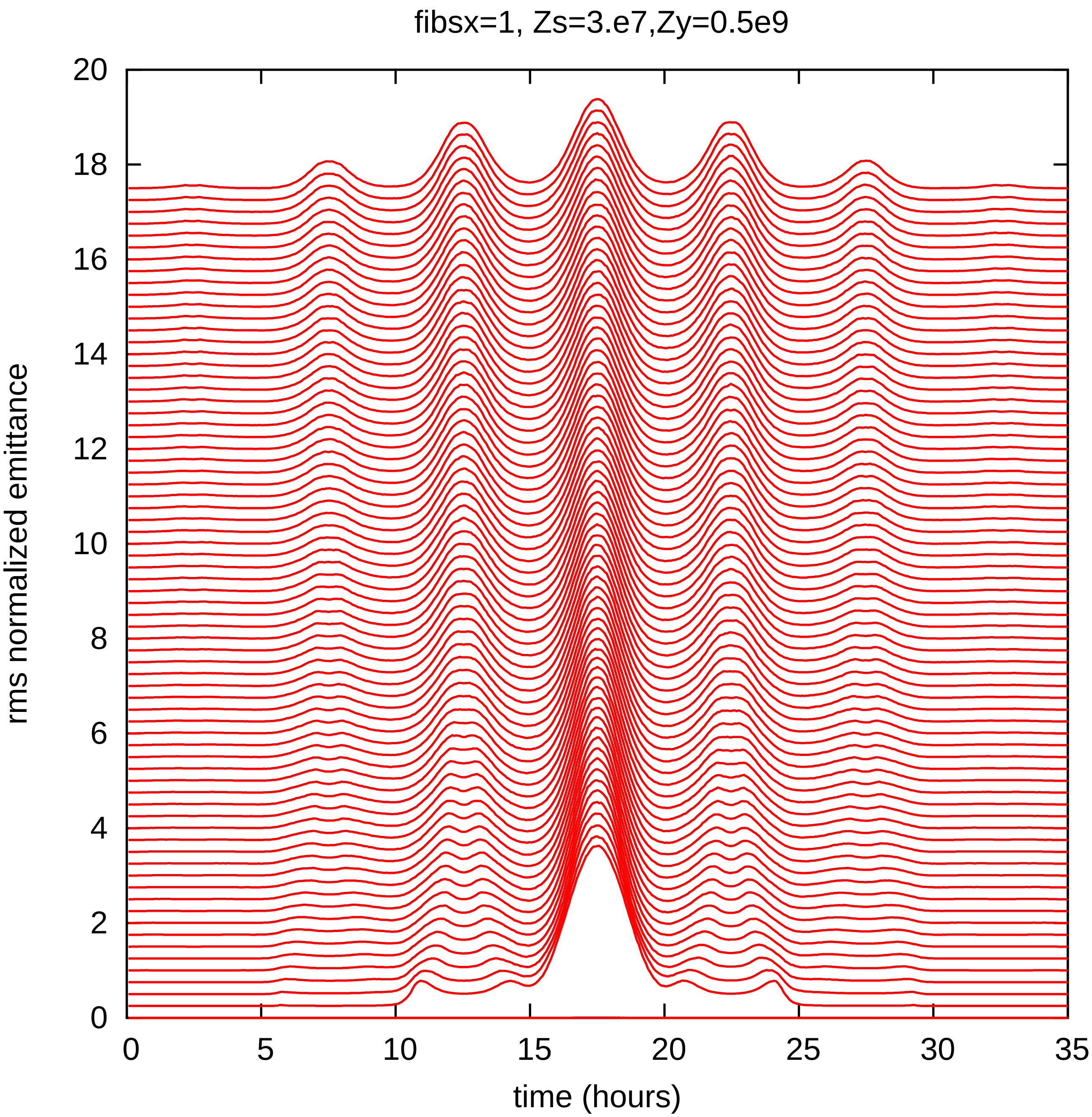
fibsx=1, Zs=3.e7,Zy=1.0e9
rms normalized emittance
time (hours)
0
2
4
6
8
10
12
14
16
18
20
0
5
10
15
20
25
30
35

Plot 10

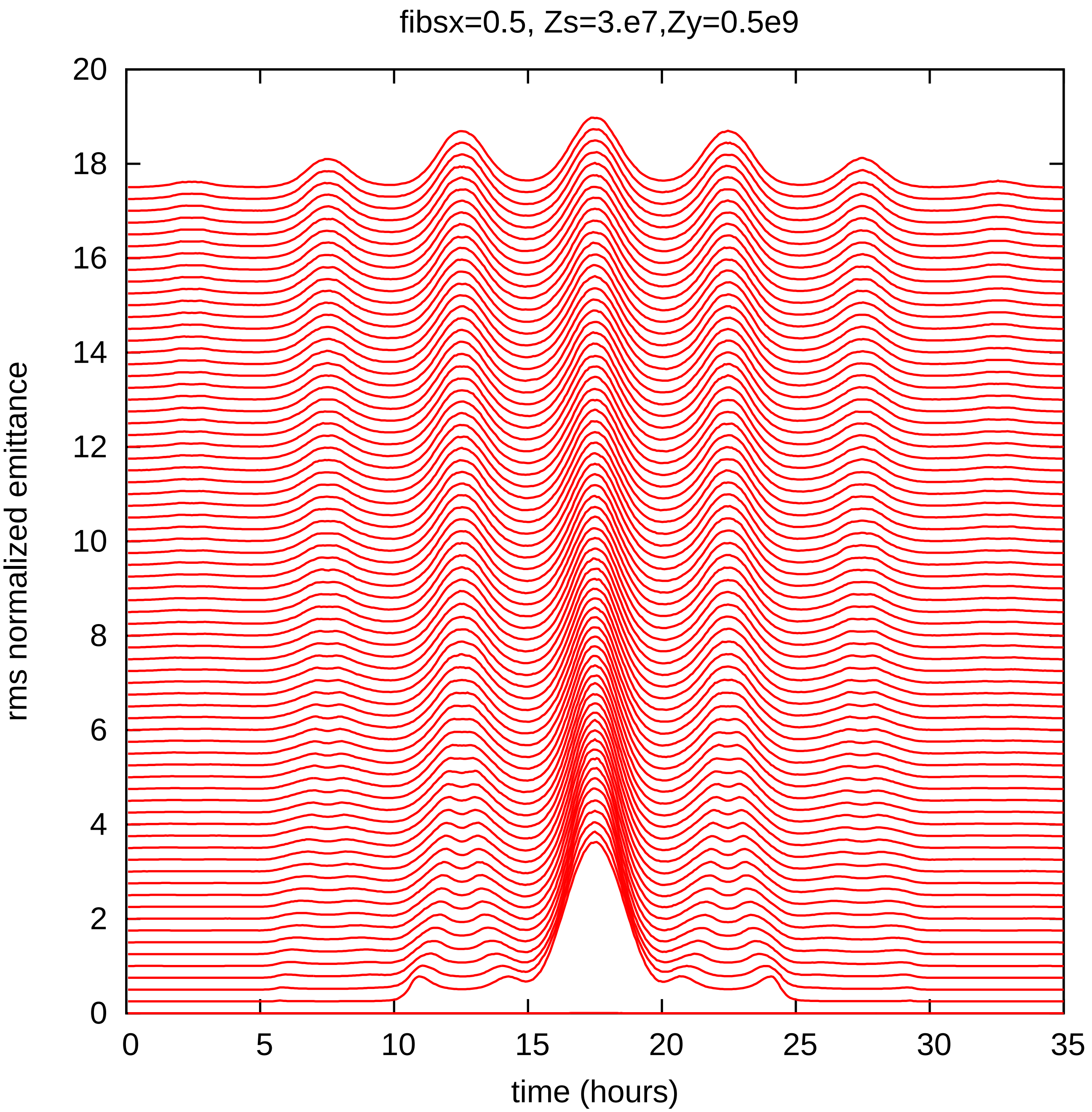


fibsx=0.5, Zs=3.e7,Zy=1.0e9
rms normalized emittance
time (hours)
0
2
4
6
8
10
12
14
16
18
20
0
5
10
15
20
25
30
35

Plot 11

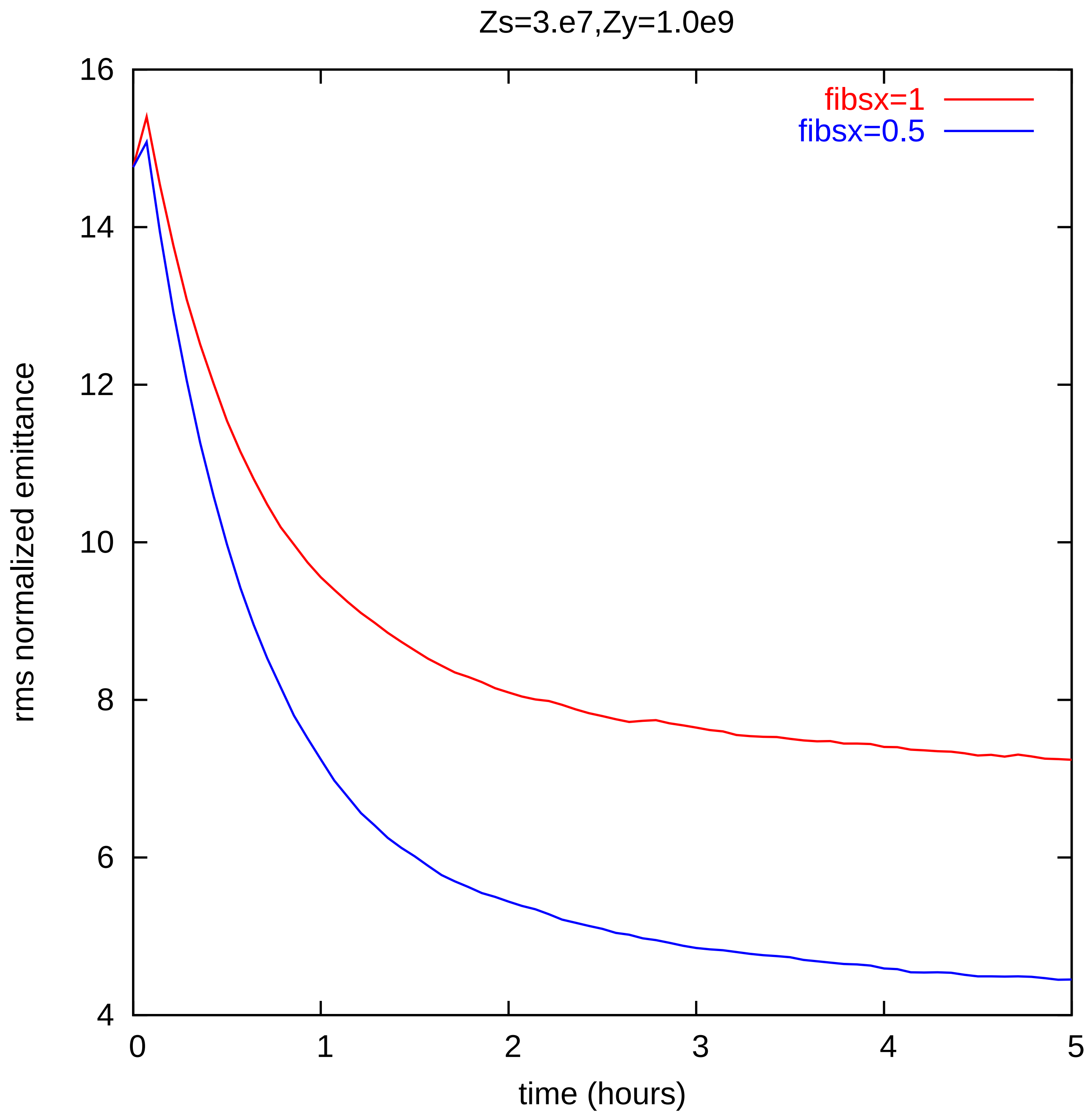


fibsx=1, Zs=3.e7,Zy=0.5e9
rms normalized emittance
time (hours)
0
2
4
6
8
10
12
14
16
18
20
0
5
10
15
20
25
30
35


fibsx=0.5, Zs=3.e7,Zy=0.5e9
rms normalized emittance
time (hours)
0
2
4
6
8
10
12
14
16
18
20
0
5
10
15
20
25
30
35

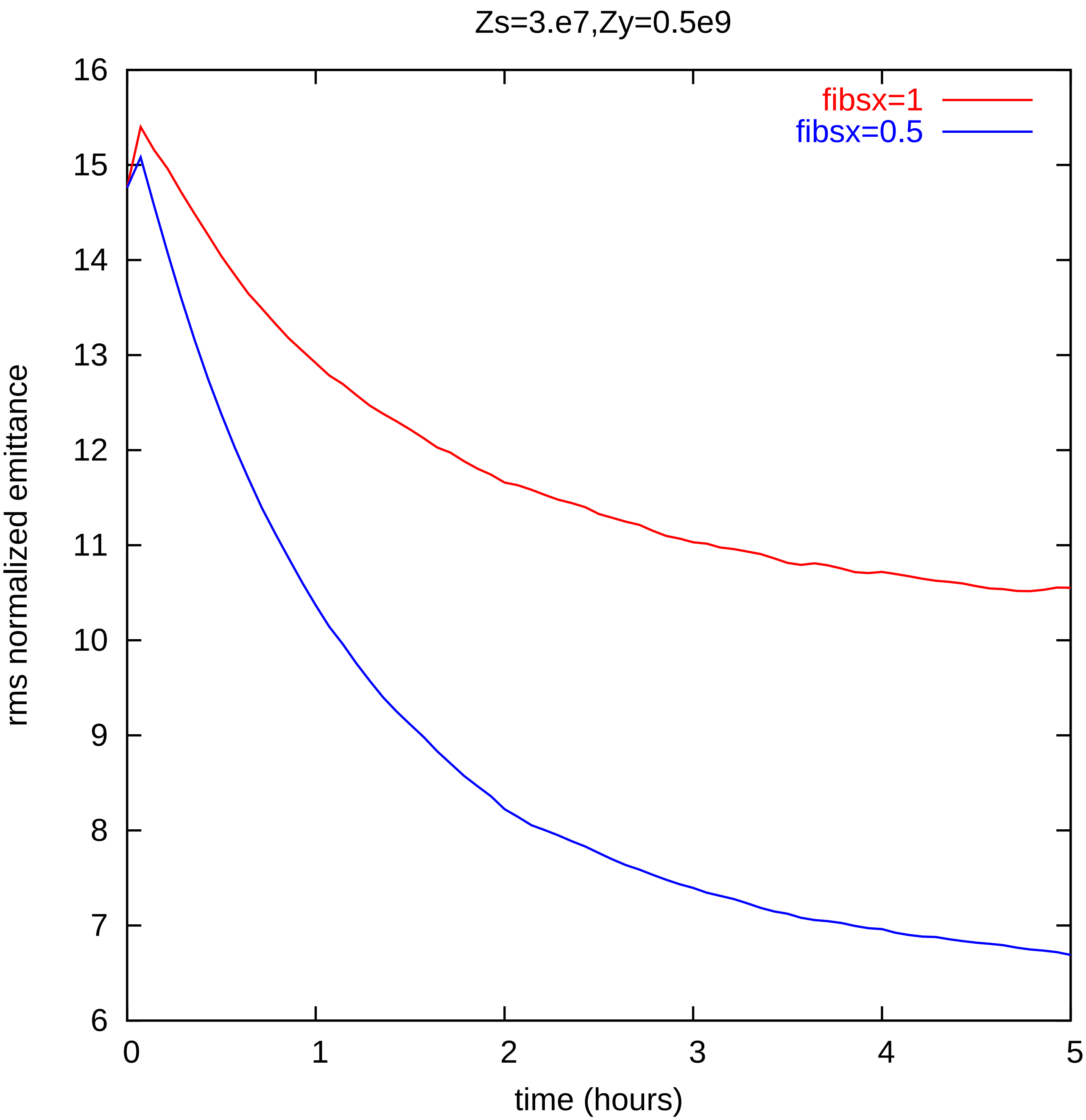
Plot 12

Plot 13



Zs=3.e7,Zy=1.0e9
fibsx=1
fibsx=0.5
rms normalized emittance
time (hours)
16
14
12
10
8
6
4
0
1
2
3
4
5

Plot 14


Zs=3.e7,Zy=0.5e9
fibsx=1
fibsx=0.5
rms normalized emittance
time (hours)
16
15
14
13
12
11
10
9
8
7
6
0
1
2
3
4
5